PHENOMENAL DISTANCE OF MIDGROUND AND BACKGROUND ITEMS IN IMPOVERISHED PHOTOGRAPHS

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ABSTRACT

PHENOMENAL DISTANCE OF MIDGROUND AND BACKGROUND ITEMS IN IMPOVERISHED PICTURES

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A number of studies have indicated that, under certain conditions, an item will appear to be closer when shown on the left side of a photographic print than when appearing, at a metrically equal distance, on the right side. Typically, these studies have: 1. employed pictures which displayed a large number of stimulus depth cues; 2. used pictures in which the critical item appeared in either the foreground or the midground.

Using impoverished photographs (prints with only a few stimulus depth cues), the purpose of the present study was to determine if a left-right imbalance occurs when the critical object is large and appears in the midground; or when the critical object is small and appears in the background.

Twelve subjects, who met both a 20/20 visual acuity criterion and a criterion of variability in a practice series, were asked to match the phenomenal distance of a critical object in a large print to the phenomenal distance of the same object in a small one. The subject accomplished this task by varying the viewing distance of the large print. This procedure was repeated for a total of twelve large-small print combinations.

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The results of the study tend to indicate that: 1. A large object appears to be closer when shown in the midground of a print in which it is positioned on the left than in the mirror image of this print. 2. A left-right imbalance does not occur when the critical object is small and appears in the background. This is true when: 1. It is the only object in the scene. 2. A large object also appears in the background. 3. A large object appears in the foreground.

Approved By: [illegible]

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INTRODUCTION

Phenomenal distance is defined as the apparent nearness of an object in the visual field. Recently, investigators have been concerned with stimulus variables of relevance to the study of phenomenal distance.

In studies using photographs, print size has been shown to be a variable that determines apparent nearness of an object in the visual field. Bartley and Adair (3), employing a psychophysical matching technique, found that as print size increased, apparent nearness of various objects in the visual field increased. Thompson and Bartley (21) in a later study confirmed these results.

In a study conducted by Bartley (2), two methods of enlarging the figure size of a critical object (the object whose distance was judged), were examined. In one set of pictures, figure size was increased by a standard enlarging procedure. In a second set of photographs, figure size was varied by print cropping. Both methods were found to be equally effective in changing the phenomenal distance of the critical object. The results corroborated those obtained in earlier studies (3, 21).

Viewing distance (i.e., distance from the S to a target) has also been shown to be related to phenomenal distance.

A series of studies (14, 15, 16, 17) indicates that the depth of the visual field is an increasing monotonic function of viewing distance. These studies also show that estimates of height and size of various items in photographs remains constant over varying distances between the S and the target.

In another series of studies (7, 19, 20), in which the Howard-Dolman apparatus for studying distance judgment was employed, it was demonstrated that the linear threshold of equality of judgment was an increasing monotonic function of viewing distance.

Bartley and Adair (3), using a psychophysical matching technique, showed that as the distance between a standard target and a S increased, a concurrent increase in the distance between the S and variable target had to occur in order for the PSE to remain constant. This substantiates studies cited earlier (14, 15, 16, 17).

On the basis of their research, Thompson and Bartley (21) suggest that higher order stimulus variables may bare a relationship to phenomenal distance of critical objects. In their study, the apparent nearness of a man shown in a photograph was found to be related to the direction in which that man was facing. Even though metrically equal in distance, a man appeared to be closer when facing the S than when facing in a direction opposite to the subject.

A large body of research suggests that apparent distance is also determined by the lateral position of various objects in the visual field. One of the first investigators to recognize this fact was Gaffron (8). Her subjects were asked to compare classical paintings with their mirror images. They reported that there were differences in the subjective impressions between the two sets of paintings. One difference was that items in the left of the visual field, under certain conditions, appeared to be closer than when appearing on the right (i.e., in the mirror images). Gaffron suggests that the better artists have, at least implicitly, noticed that the left and right halves of the visual field function differently and have utilized this difference to produce desired effects in their paintings.

Recent studies have attempted to quantify left-right differences by using a psychophysical matching technique. Adair and Bartley (1) using five scenes and their mirror images, in which a large object appeared either in the foreground or midground, found that objects appeared to be closer when placed in the left of the photograph. The greater the asymmetry in the scenes, the more pronounced this left-right imbalance became.

Bartley and Thompson (6), employing the same psychophysical technique, confirmed the results of the Adair and Bartley study. In this investigation, a man was seen in the midground at various positions in the left and right halves of the field. The man appeared to be closer when on the left than when on the right side of the picture; the left-right imbalance was enhanced with increasing degrees of asymmetry.

Current literature offers very little explanation of the results of experiments involving the lateral position variable. It could be argued that differential effects are related to what have classically been referred to as "depth cues" or what Gibson (10) refers to as "gradients of stimulation." If this is true, some of the studies cited are not comparable because: 1. different types of stimulus conditions which are necessary for the perception of depth, were used, i.e., different types of visual depth cues; 2. differing numbers of depth perception stimulus conditions were used, i.e., some studies used pictures in which a few depth cues appeared while other studies used pictures with a large number of depth cues.

There is some research that suggests that phenomenal distance is not related to variations in depth inducing stimulus conditions.

Smith (15) altered Gibson's stake photographs in order to determine what stimulus conditions are critical for accurate distance judgment. Three sets of photographs were used in the study: appearing in one set of pictures were fully detailed (texture and shadows) fields; in another set, only stakes and their shadows were shown; in a third set, the field was impoverished so only the standard and variable stakes could be seen. Ss followed the procedure used in the classical studies of Gibson (10). Distance judgments were found to be equally accurate with the three stimulus conditions. Smith suggests that the critical "cue" involved is the subject's knowledge of the height of the camera.

In a study performed by Smith, Smith and Hubbard (17), Ss were asked to compare, (by ratio judgments of distances), five pictures of the same corridor. The pictures differed in amount of detail and shadowing; some pictures were photographs of the corridor, others were drawings. Ratio judgments were not found to be related to the differences in the degree of impoverishment in the pictures.

Teichner, Kobrick, and Dusek (19), using a standard psychopysical matching procedure for examining distance judgment in a three dimensional field, concluded that variations in terrains of the fields used did not systematically change distance judgment. Teichner, Kobrick, and Wehkamp (20), employing the same method, also found that terrain textual differences and distance judgments were not related.

The earlier mentioned studies of Adair and Bartley (1) and Bartley and Thompson (6), using photographs in which a large number of depth inducing stimulus conditions existed, found that a large midground item appeared closer when appearing on the left than when on the right. It would be expected that this difference will also occur where the depth inducing properties of a photograph are few in number.

Recent research indicates that there are other factors that determine subjective differences between the left and right havles of the visual field.

Gogel (11) has demonstrated that the phenomenal distance of a small critical object is affected by the presence of larger objects appearing in the field. A large square was found to affect the apparent nearness of a small disc when the two figures were relatively distant to one another.

The importance of large items in determining the apparent nearness of smaller items in the field of vision has been demonstrated by two recent studies (5, 13). In both investigations, phenomenal distances of a small block in the foreground were compared when both the lateral position of the block and the lateral position of trees in the background were varied. The small block appeared to be closer when placed on the left only when the trees appeared on the right. Thus, larger background items affect the phenomenal distance of small foreground items.

In the same two studies (5, 13), it was also shown that large foreground objects appear to be closer than small foreground objects which are placed in the same position in the photograph. It seems that the left-right imbalance of a small foreground item is determined by the presence of a large background object whereas the apparent nearness of a large foreground item is independent of other items present in the field (13).

Bartley and DeHardt (4) find that, under certain conditions, a left-right imbalance does not occur when the critical object appears in the background. Appearing in the photographs used in their study was a small critical object in the background and a large object in the foreground. They conclude that the left-right imbalance for the background item does not occur for this set of stimulus conditions.

Although a large number of stimulus depth cues appeared in the photographs used by DeHardt and Bartley, it would be predicted that the same results would be observed when improverished pictures are used. Because no left-right differences were observed in the DeHardt and Bartley study when a large object appeared in the foreground, it would not be expected that differences will result when a metrically smaller object is placed in the background.

Bartley and DeHardt (5) suggest that the appearance of a large item in the visual field is critical to the occurance of left-right differences in photographs. A small critical object appears to be closer when on the left only when a larger item is shown in the scene. This predication is substantiated by several studies (5, 13). If this assertion is correct, it would be predicted that an item on the left would appear to be equally distant to an item on the right when the only item in a scene is a small background object.

To summarize, using impoverished photographs, the following hypotheses will be tested in the present study:

I. A large midground item will appear to be closer when located on the left than when located on the right of a scene.

II. There will not be a left-right imbalance when the critical object is a small object appearing in the background. This will be true when: 1. the small object is the only item in the visual field; 2. when a large item is located in the foreground; 3. when a large item appears in the background.

METHOD

Subjects

Twelve students (11 males and one female), in an introductory experimental psychology course at Michigan State University, served as subjects.

Apparatus

The apparatus shown in Figure 1, consisted of an adjustable carriage mounted on a 275 inch calibrated track; a stationary target holder for a 4 x 4 print, positioned to the right of this; and a chin rest placed behind, and to the right of a blind. Because of this structure, observations were made with only the right eye.

Placed on the carriage was a target holder for an 8 x 8 print. Turning a knob positioned to the left of the S, moved this print along the track. Targets were seen against a flat black background with diffuse overhead lighting.

A total of 14 black and white photographs (eight 8 x 8 and six 4 x 4 prints) were used in the study. The photographs, as shown in Figure 2, for the purpose of experimental presentation, were divided into four sets (combinations of large and small prints).

Set 1 consisted of two large and one small print. Shown in the prints was a large block in the midground. In the two large prints, the block either appeared at the

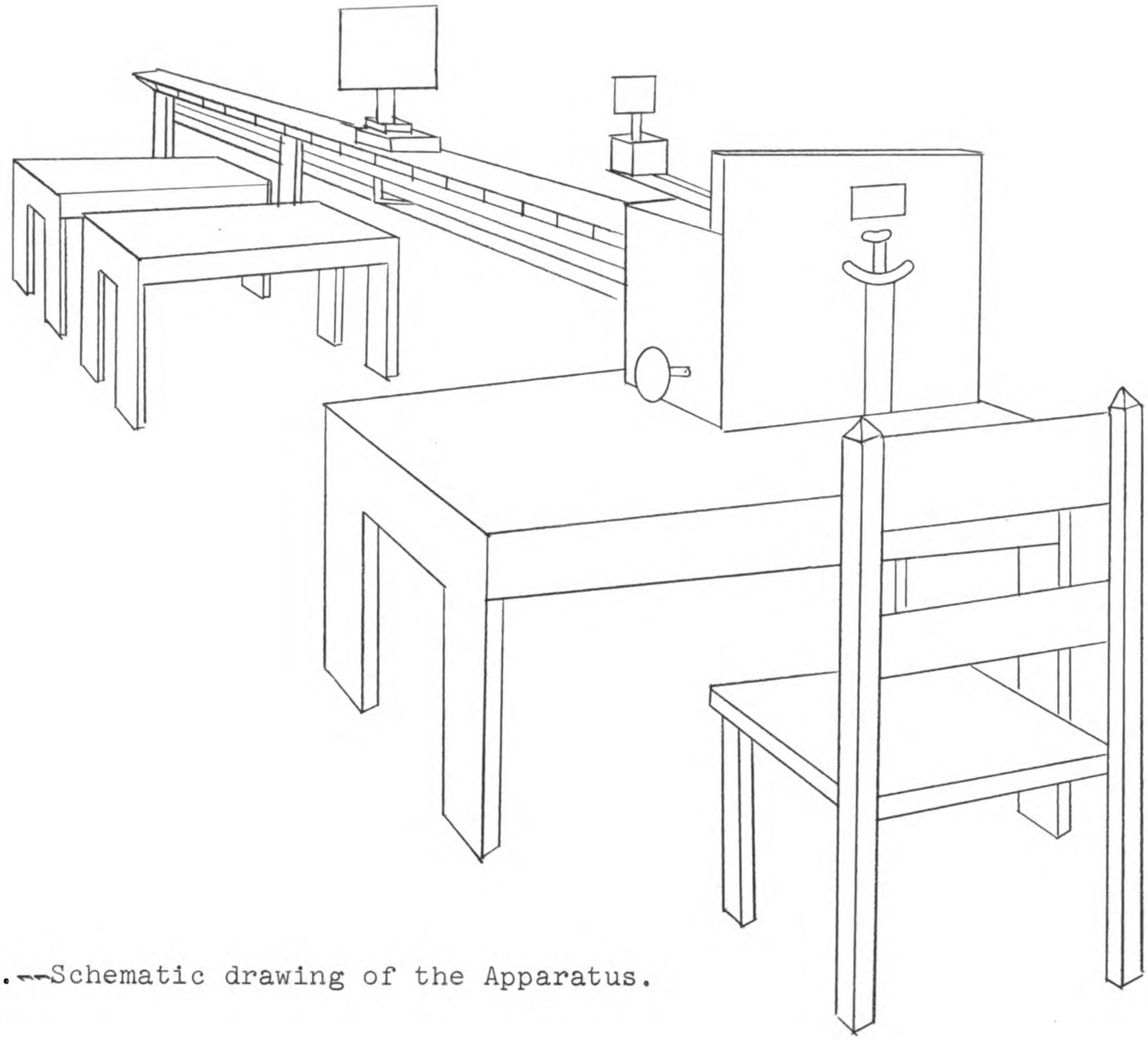

Figure 1.--Schematic drawing of the Apparatus.

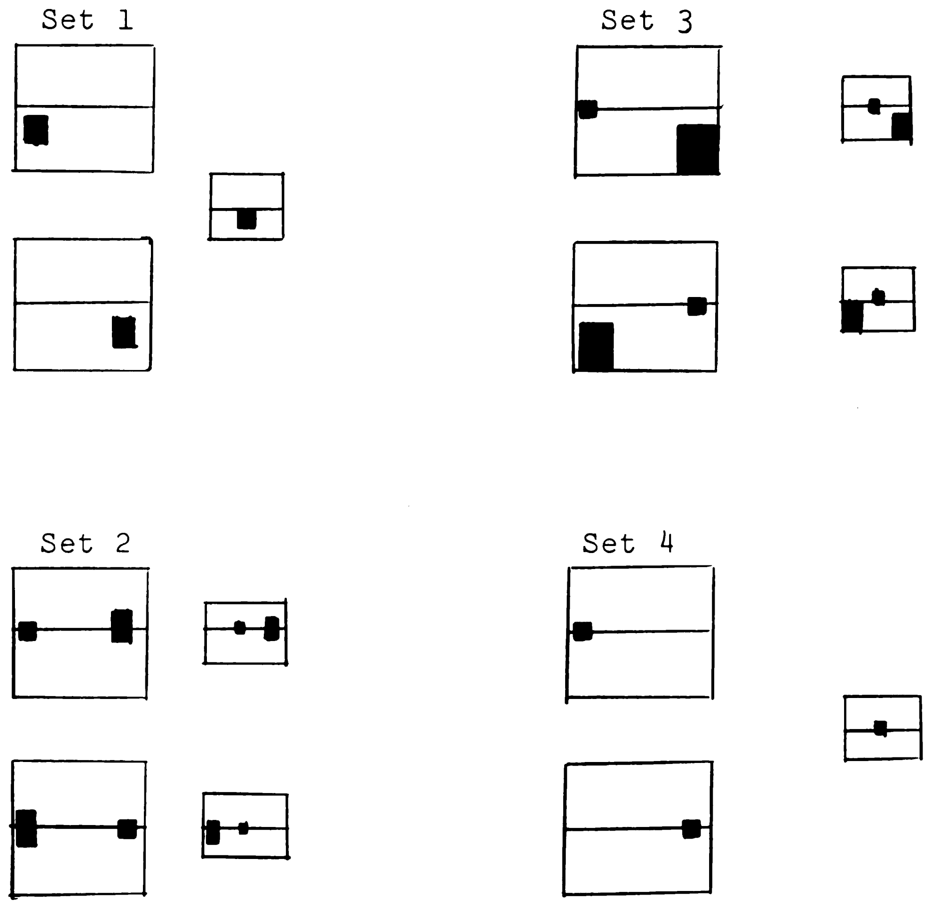

Figure 2.--Schematic drawings of 4 x 4 standard prints and 8 x 8 variable prints used in the study.

extreme left or at the extreme right. In the small print, it was shown in the center of the picture. There were two large-small print combinations in this set.

Appearing in the background of Set 2, were a small and large block. In the two large prints, the small and large blocks always were shown on opposite sides (to the extreme right or the extreme left). In the two small prints, the small block always appeared in the center of the background; the large block was seen either to the extreme right or the extreme left of center. Hence, there were four combinations of large and small prints in this set.

Set 3 was the same as Set 2 except the large block appeared in the foreground. There were four possible print combinations in this set.

A small block in the background was the only figure in Set 4. In the two large pictures, it either appeared on the extreme right or the extreme left. In the small print, it appeared in the center of the background.

In describing the targets, F, M, B refer to the vertical position of a particular block; L, C, R, refer to the lateral position of the block; (C), (N) refer to whether or not the block designated is the critical one, i.e., the one whose phenomenal distance is under consideration. Large case letters are used to denote blocks in the large prints; small case letters are used to denote blocks in the small prints. Hence, LB(N) refers to the large print in which a large block appears in the left of the background and a small block in the right of the background; rf(n) refers to the small print where a large block appears in the right foreground and a small block appears in the center of the background.

Procedure

Using a "tumbling E" acuity chart, Ss were tested for visual acuity. Only individuals with acuity of 20/20 or better in the right eye served as Ss.

Since Gibson (9) and others have indicated the necessity of a control for learning in experiments of this nature, a further criterion for participation was established.

Subjects were presented with various combinations of the following practice targets: LM(N), RM(N), lm(n), rm(n). As in Sets 2, 3, and 4, of the main experiment, a small critical object appeared in the background.

On a given trial, a small print was placed 29 inches from the S, in the stationary target holder; a large print was randomly positioned along the calibrated track. S was seated before the apparatus and given the following instructions:

> This is an experiment in distance judgment. Rest your chin on the chin rest. Now you should be able to see the pictures only with your right eye. I want you to move the large picture with this knob until this object (the small block) looks as far

away from you as the one in the small picture. The objects should look the same distance from you, not the same size. I'll give you several practice trials, so go ahead and try it.

When a S was uncertain of his task, he was told: "One subject imagined he was in the scene, and put the large photograph where he would have to walk the same distance to get to the objects in the two pictures."

During practice trials and during the main experiment, Ss were told they could repeat any trial if they were not satisfied with the match. They were also free to rest whenever they desired.

A S was permitted to start the main experiment when the standard deviation of four consecutive matches for each of the four combinations of prints, was five inches or less. If this criterion of variability was not met in 35 minutes, the S was not permitted to participate in the main experiment. One potential subject was eliminated on the basis of the criterion.

In the main experiment, the same instructions and procedure were used. The order of presentation for each set of target combinations was randomly varied. Four measurements for each of the twelve picture combinations were taken.

RESULTS AND DISCUSSION

Using Lindquist's Treatment by Subjects design (12, p. 160), an analysis of variance for each of the four sets of prints was made. The results of the analysis are presented in Table I.

A correlated T test was performed for the data for print Set 1. The computed T of 4.01 was significant at the .01 level.

An F max test for homogeneity of variance was conducted for each of the four print sets. In no case was F max large enough to permit rejection of the hypothesis of homogeneity of variance.

In general, the results tend to confirm the hypotheses proposed.

Hypothesis I.--On the basis of several studies (1, 6, 15, 17, 19, 20), it was expected that the large block shown in the midground of prints of Set 1 would appear to be closer in the large print in which it was shown on the left than in the mirror image of this print. This phenomenal difference would be indicated by subjects positioning the large picture at a greater distance for the LM(C)-c(c) combination than for the RM(C)-c(c) combination. Both the F test and the correlated T test, as indicated in Table I, show this to be the case. (Also see Figure 3).

Table 1.--Summary of analysis of variance based on the scores for each subject for four print sets.

Print Set 1. Large Block in Midground

Source	SS	DF	MS	F
1. Lateral Position	429.3	1	429.3	16.07*
2. Subjects	4,068.8	11	369.84	35.57**
3. Subjects x Position	293.7	11	26.70	2.567
4. Error	251	24	10.4	
TOTAL	5,042.8	47		

Print Set 2. Large Block in Background and Small Block in Background

Source	SS	DF	MS	F
1. Lateral Position	254	3	84	1.20
2. Subjects	13,814.8	11	1255.89	266.68**
3. Subjects x Position	2,309.2	33	69.97	490.2**
4. Error	679	144	4.71	
TOTAL	17,057	191		

Print Set 3. Large Block in Foreground and Small Block in Background

Source	SS	DF	MS	F
1. Lateral Position	192.64	3	64.21	1.297
2. Subjects	9,711.21	11	882.84	198.39**
3. Subjects x Position	1,655.89	33	50.18	11.28**
4. Error	641	144	4.45	
TOTAL	12,200.74	191		

Print Set 4. Small Block in Background

Source	SS	DF	MS	F
1. Lateral Position	17	1	17	1.7
2. Subjects	9,651.5	11	877.4	53.17**
3. Subjects x Position	105.0	11	9.5	.57
4. Error	397	24	16.5	
TOTAL	10,170.5	47		

* Significant at .01 level

** Significant at .001 level

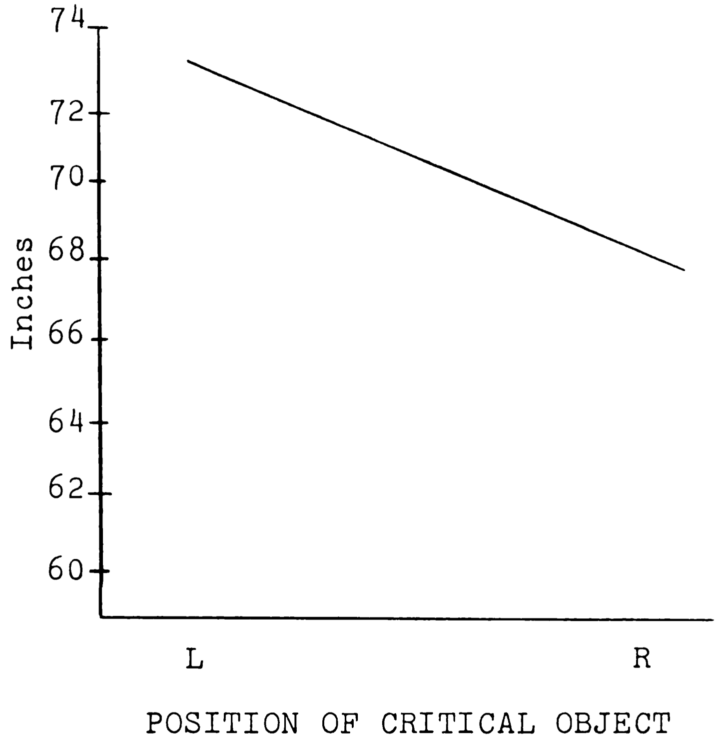

Figure 3.--Mean distances for set 1, large block in mid ground.

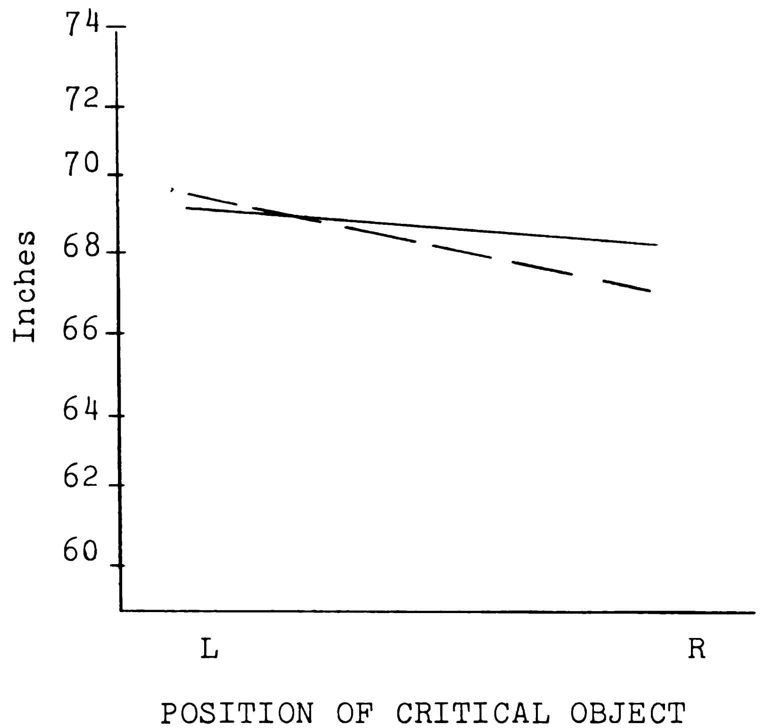

Figure 4.--Mean distances for set 2, large block in background, small block in background.

——— RB(N)-rb(n): LB(N)-lb(n)
----- RB(N)-rb(n): LB(N)-rb(n)

<u>Hypothesis II</u>.--Based on the study of Bartley and DeHardt (4), it was predicted that there would not be a left-right imbalance when the critical object was small and appeared in the background of the prints. This was expected to be true when: 1. the small object was the only item in the field; 2. when it was shown with a metrically larger object appearing in the background; 3. when a large object appears in the foreground.

Statistically non-significant values of F for each of the three sets of prints (2, 3, 4) in which a small block in the background was shown, tends to give support to this hypothesis (See Table I). Because there was a sizable difference between the means of the print pair combinations LB(N)-lb(n) and RB(N)-rb(n) and LB(N)-lb(n) and RB(N)-lb(n) of print Set 2 and print pair combination LF(N)-rf(n) and RF(N)-rf(n) of Set 3 (2.78, 2.67, and 2.63, respectively), the possibility of a position variable operating when a small block in the background is the critical object, cannot be totally eliminated (See Figures 4, 5, 6). Future research will have to substantiate this assertion before an unequivocal statement can be made.

Why a left-right imbalance should not be observed for a small background item, is not immediately apparent. Perhaps, the answer to the question can be found through a better understanding of the method employed in the present study.

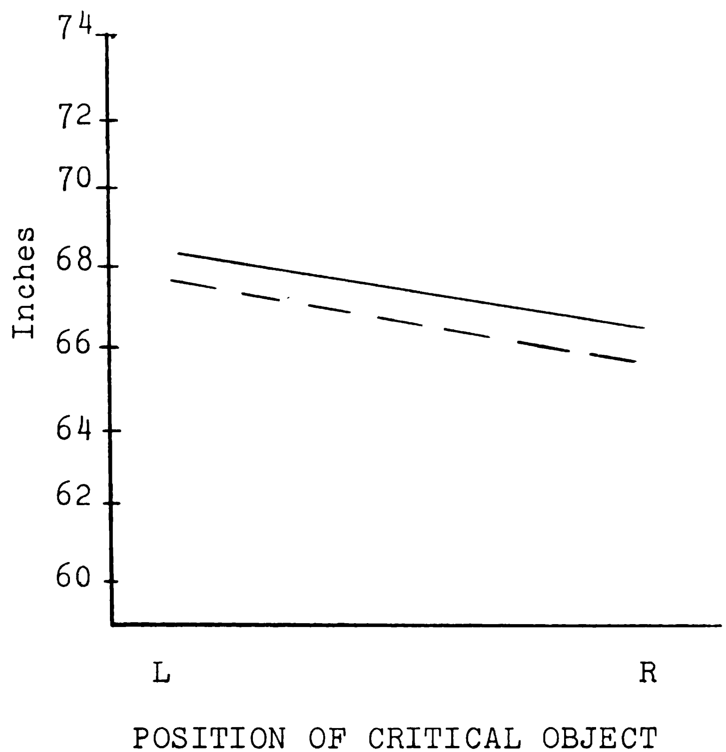

Figure 5.--Mean distances for set 3, large block in foreground, small block in background.

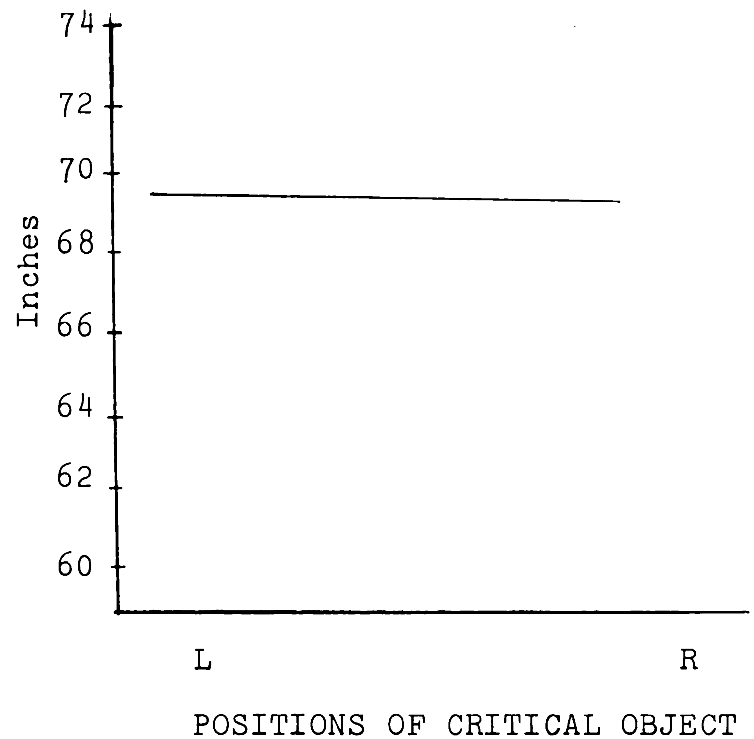

Figure 6.--Mean distances of set 4, small block in background.

____RF(N)-rf(n): LF(N)-lf(n)
----RF(N)-lf(n): LF(N)-rf(n)

As a S moves the large photograph along the calibrated track, two changes occur. Changing as the large print's position varies, is the retinal image size of objects in the visual field. As the distance between the S and the target is increased, the visual angle subtended by the large print decreases; hence the retinal image size of the print becomes smaller. At first, investigators thought that the S matched the visual angles of the critical object in the small print to the visual angle of the critical object in the large print. Several studies, (2, 3, 6), however, have shown that retinal image size alone does not determine phenomenal distance.

A second change that occurs with variations in the distance between the subject and the large print is perceptual. The apparent depth, or distance between the foreground of the scene and the critical object, varies. As the distance between the S and large print is increased, this apparent distance (i.e. apparent depth) also increases. It might be hypothesized that this is sole basis for matchs made. In view of the instructions given to the S, this seems to be the most tenable position. If this hypothesis is accepted it would be assumed that the apparent depth of the critical object in the small print would be some fixed value and that the S varies the distance of the large print until the depth of objects in the two photographs is the same. An inference drawn from this hypothesis is that the metric size of the critical object is not a relevent stimulus variable. Two studies (5, 13) indicate, however, that a large object appears to be closer than a small object shown at the same metric distance. It seems that phenomenal distance is determined both by retinal image size and the apparent depth of the critical object.

Bartley and DeHardt (5) assert that the left-right imbalance does not occur when: 1. a metrically small object is the only item in the visual field; 2. the critical object is in the background. From this it can be inferred that a critical item, when appearing alone must subtend some minimal visual angle; similarly the apparent depth of the critical object in the visual field, must not be beyond some critical value if a left-right imbalance is to be observed. It is certainly not coincidental that the crucial factors involved are retinal image size and apparent depth; the two factors which were shown to be the co-determiners of phenomenal distance.

Before any more conclusive statements can be made, future studies will have to determine: 1. if a left-right imbalance is observed with a single large background object; 2. if differential effects result when a single small object appears in the foreground or when a single small object appears in the midground.

Gaffron (8) hypothesizes that the left-right imbalance is related to hemispheric dominance in the brain. If the phenomenon is in some way related to body asymmetry, the data obtained when employing the method of the present study may be biased. The position of the standard print was always to the right of the S while the comparison target was always to the left. Ss always varied the distance of the large picture with the left hand. Observations were always made with the right eye. A recent study by Schneider (18) has shown that sensory-tonic data must be reinterpreted on the basis of similar methodological biases.

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APPENDIX A

APPENDIX I

Scores for each subject on each condition, and mean scores for each condition.

S	LF(N)-lf(n)	LF(N)-rf(n)	RF(N)-rf(n)	RF(N)-lf(n)
J. M.	72.75	76.75	76.00	71.50
M. N.	73.50	71.00	73.75	73.00
D. G.	54.75	54.25	69.75	62.25
P. V.	59.75	63.50	57.25	56.00
S. J.	56.50	49.75	58.00	58.25
D. E.	70.00	72.00	70.75	71.25
D. S.	76.25	77.25	72.50	70.75
M. M.	68.50	67.00	75.75	77.50
C. H.	73.00	72.75	73.75	79.75
G. W.	71.75	67.25	73.25	73.00
A. L.	55.50	57.50	56.25	57.00
R. B.	70.25	63.75	66.75	65.25
$\bar{X}$	67.00	66.02	68.65	67.94

S	LB(N)-rb(n)	LB(N)-lb(n)	RB(N)-rb(n)	RB(N)-lb(n)
J. M.	74.50	75.50	75.00	75.00
M. N.	69.00	71.00	71.50	67.00
D. G.	70.00	66.50	80.25	79.75
P. V.	60.75	58.25	58.25	58.25
S. J.	52.50	52.75	51.00	54.75
D. F.	72.50	69.75	72.25	69.25
D. S.	69.50	69.75	69.75	69.25
M. M.	65.25	74.00	85.50	88.75
C. H.	76.25	83.75	76.00	76.50
G. W.	75.50	71.75	71.00	73.25
A. L.	54.75	52.15	53.50	53.00
R. B.	64.75	72.75	74.50	72.50
X	67.10	68.21	69.88	69.77

	LB(C)-cb(c)	RB(C)-cb(c)	LM(C)-cm(c)	RM(C)-cm(c)
J. M.	73.75	74.75	82.25	80.00
M. N.	74.25	71.00	76.50	70.50
D. G.	72.00	72.00	69.00	70.00
P. V.	37.00	57.50	65.00	60.50
S. J.	54.25	51.00	66.25	59.00
D. E.	71.25	72.75	72.75	68.75
D. S.	73.50	73.50	81.50	75.50
M. M.	90.00	85.00	85.75	76.50
C. H.	77.75	79.00	62.75	61.25
G. W.	74.75	74.50	75.75	68.50
A. L.	51.25	54.00	71.25	64.25
R. B.	69.25	70.25	68.00	70.75
$\overline{X}$	69.88	69.60	73.06	68.83